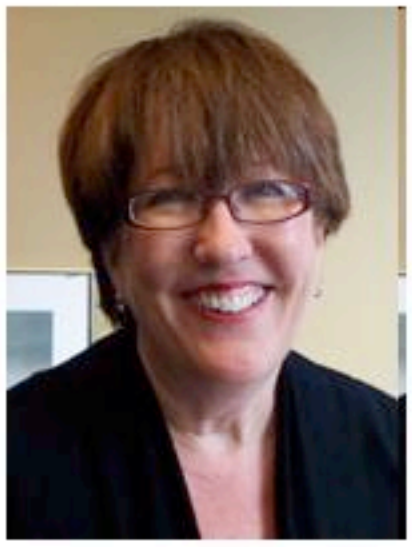
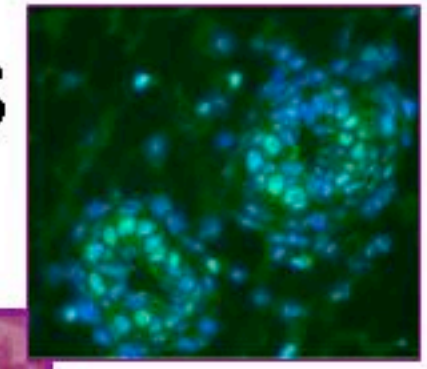
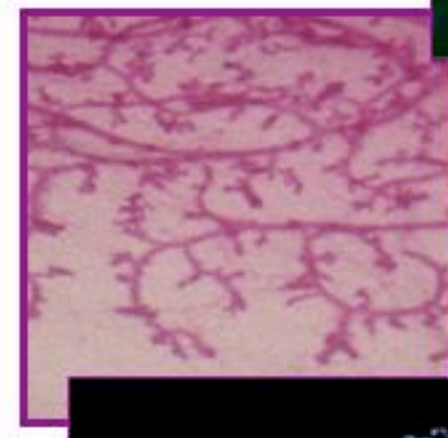
Tissue, Organelles, Organisms

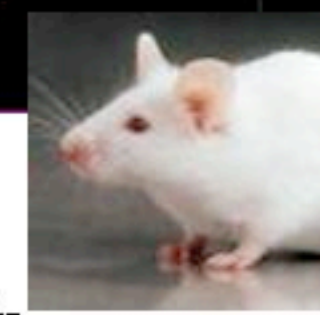


Mary Helen Barcellos-Hoff, Ph.D.
Chief Scientist, OBER Low Dose Research
Director, Radiation Biology
Assoc Professor
Depts Radiation Oncology & Cell Biology
New York University School of Medicine





Mouse mammary tissue section, whole mount, & reconstructed gland



Current Area of Research Interest

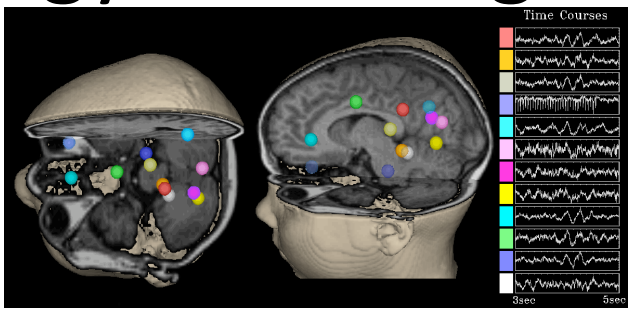
- Low dose radiation biology
- Imaging bioinformatics

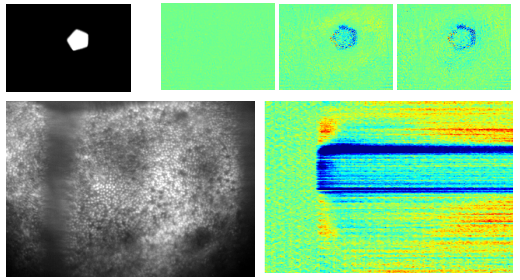
Challenges that May be Addressed with Advanced Computing and Mathematics Capabilities

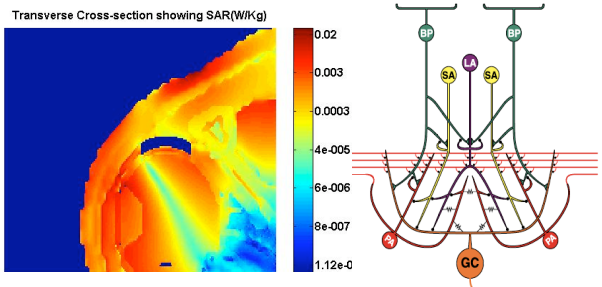
- Mapping and detecting specific molecular and chemical events in multiple populations in context
- Modeling the evolution of events/cells/organisms in a heterogeneous environment
- Predicting consequences to the organism using integrative multiscale models that are based on dynamic cellular and molecular data

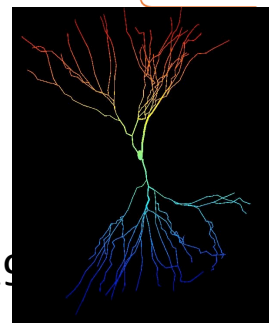
Tissues, Organs and Physiology Modeling

John S. George
Technical Staff Member
Los Alamos National Laboratory









Current Area of Research Interest

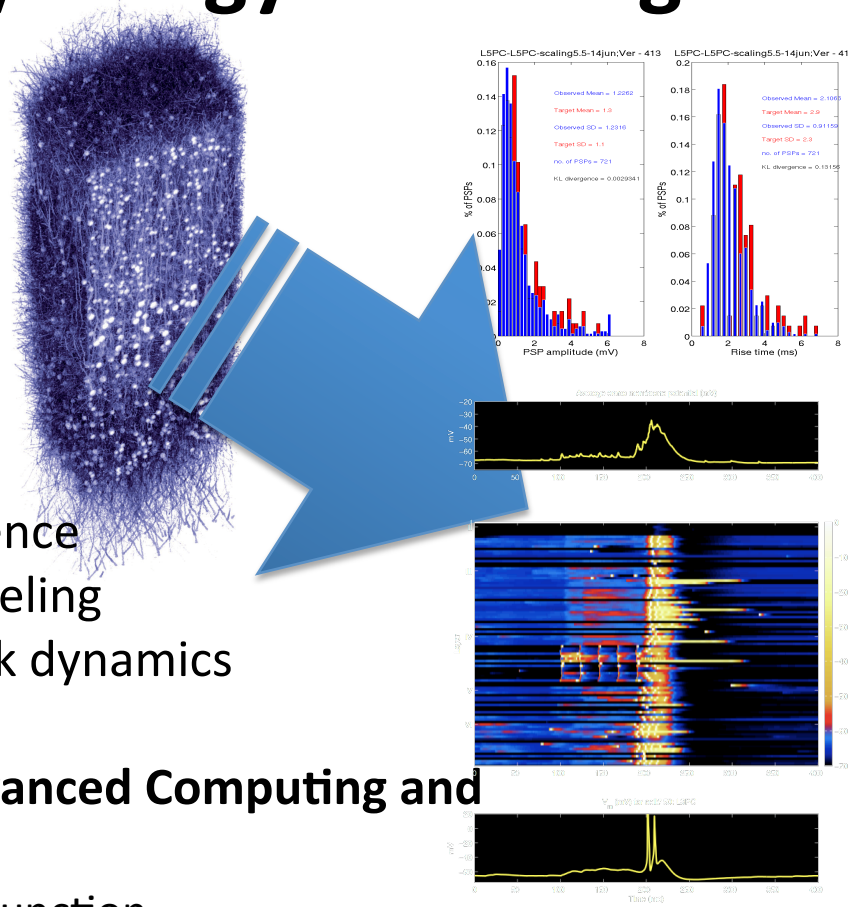
- Vision, Visual System Function, Visual Prosthesis
- Dynamic Neuroimaging of Brain Function
  - MEG, fMRI, Optical Imaging, neural current MRI
  - Source characterization, multi-modality integration
- Understanding Neural Computation

Challenges that May be Addressed with Advanced Computing and Mathematics Capabilities

- Large scale Biophysical Modeling
  - MRI functional Contrast, Neural Stimulation
- Synthetic Cognition,
  - Sensory Information Processing
- Neuromimetic and Neuromorphic Computer Systems

Tissues, Organs and Physiology Modeling

Sean Hill (PhD)
Project Manager -
Computational Neuroscience
Blue Brain/EPFL



Current Area of Research Interest

- Simulation-based research in neuroscience
- biologically detailed, physiological modeling
- learning &plasticity, large-scale network dynamics

Challenges that May be Addressed with Advanced Computing and Mathematics Capabilities

- large-scale theories of brain function & dysfunction
- predictive models for drug design
- information processing in brain circuitry

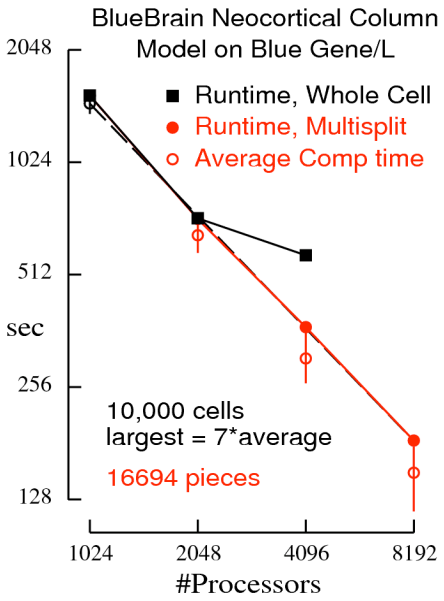
Tissues, Organs, and Physiology Modelling

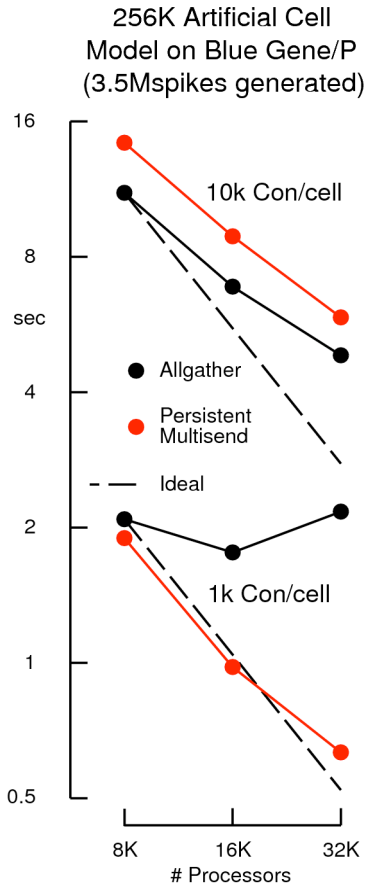
Michael Hines
Sr. Research Scientist
Computer Science
Yale University

Neural Network simulation methods

Challenges presented by availability of very large parallel computers

- **Load balance when largest neuron is much larger than average computational load per processor**
- **Overlapping computation and spike exchange: avoiding communication bandwidth limitations**





Opportunities in Biology at the extreme Scale of Computing: May 11-12

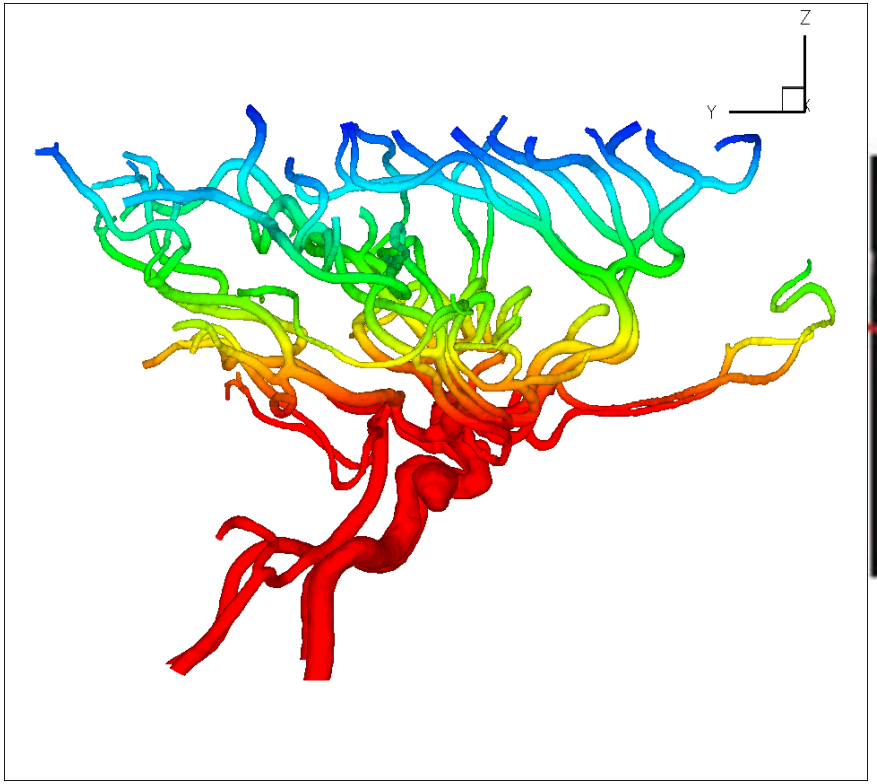
Tissues, Organs, and Physiology

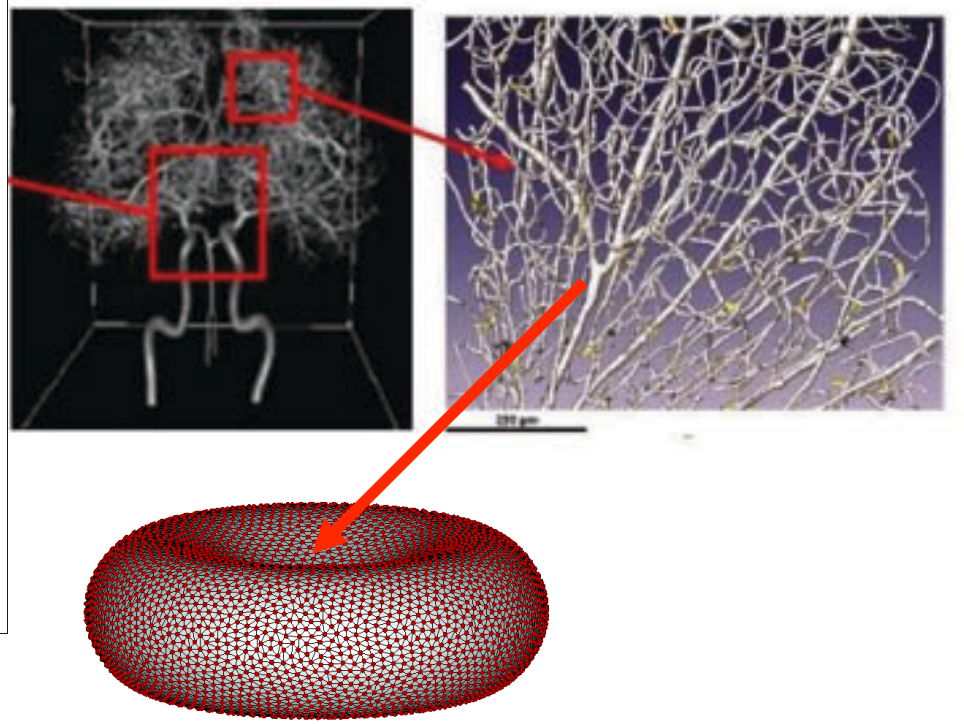
Multiscale Modeling of Arterial Trees

George Em Karniadakis
Professor of Applied Mathematics
Brown University

Computational Challenges:

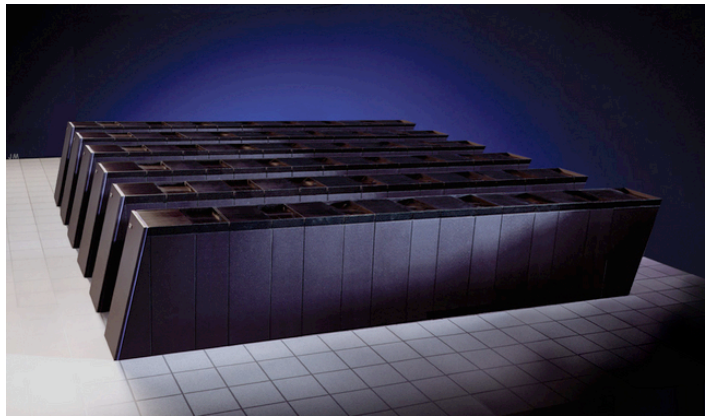
- **Solution of linear systems on 1000s Processors**
- **Coupling heterogeneous codes: atomistic-continuum**





Tissues, Organs, and Physiology Modeling

Sam Lang
PVFS Technical Lead
Argonne/MCS



Research Interest: High Performance I/O

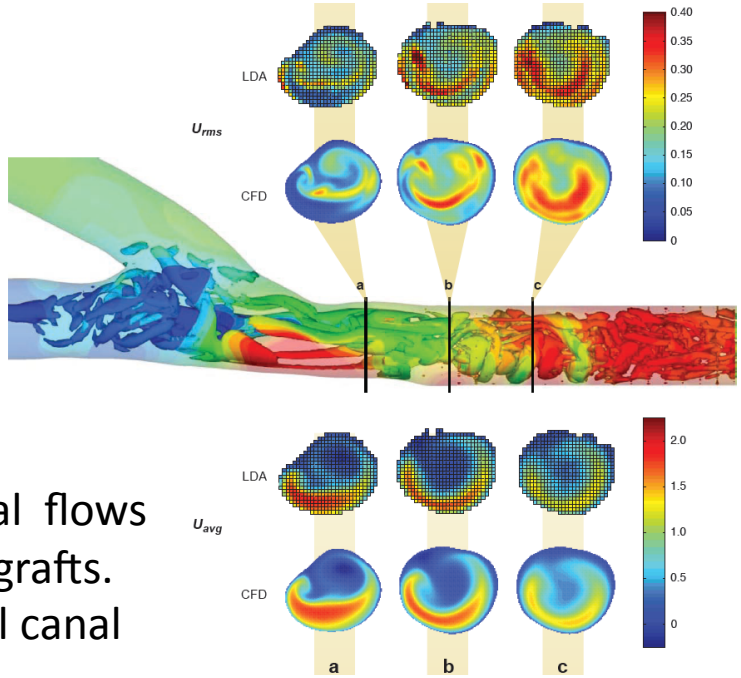
- Novel approaches to parallel I/O software
- Data-intensive computing
- I/O Interfaces for HPC Applications

Challenges addressed with Advanced Computing

- Meeting the I/O performance requirements of Biology Applications
- Providing efficient, usable interfaces to I/O and storage for Biology
- Further education of best practices I/O techniques

Tissues, Organs, and Physiology Modeling

Francis Loth
Associate Professor
University of Akron



Current Area of Research Interest

- Experimental and Computational simulation of biological flows
- Hemodynamics of the carotid bifurcation and vascular grafts.
- Hydrodynamics of cerbrospinal fluid motion in the spinal canal

Challenges that May be Addressed

- Fluids dynamics simulations of many patient specific geometries and flows for correlation between mechanical forces (shear stress and pressure) with biological markers such as disease presence and/or progression.

Tissues, Organs and Physiology Modeling

Peter Lyster
Dr
National Institutes of Health

Illustrative figure that describes research effort

Current Area of Research Interest [Include graphic]

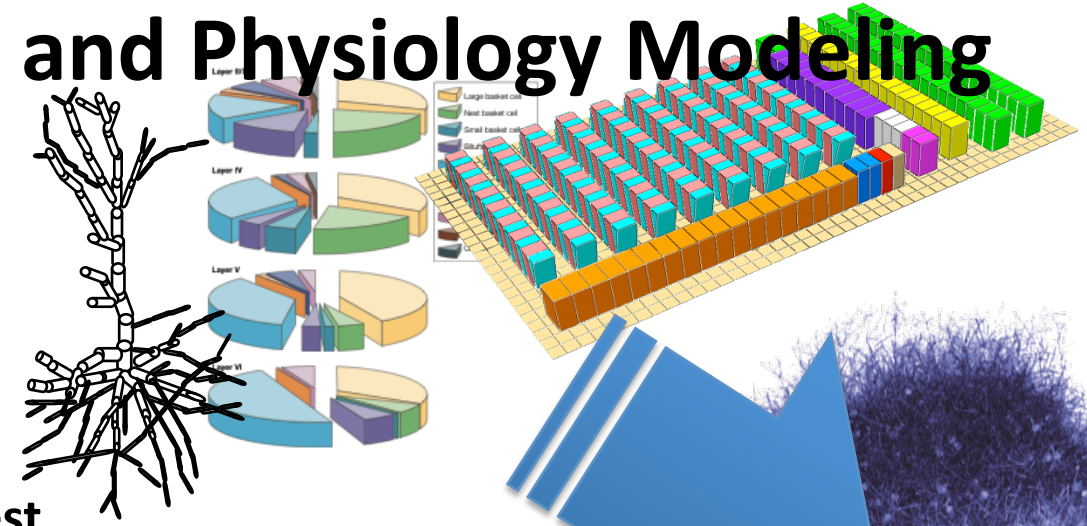
- Biomedical Modeling at multiscales
- Biomedical Analysis
- Biomedical Data management

Challenges that May be Addressed with Advanced Computing and Mathematics Capabilities

- Limits to what underlying mechanistic algorithms are computable
- Limits to what underlying mechanistic algorithms can be validated with theory or data
-

Tissues, Organs and Physiology Modeling

Dr. Felix Schürmann
General Project Manager
Blue Brain/EPFL

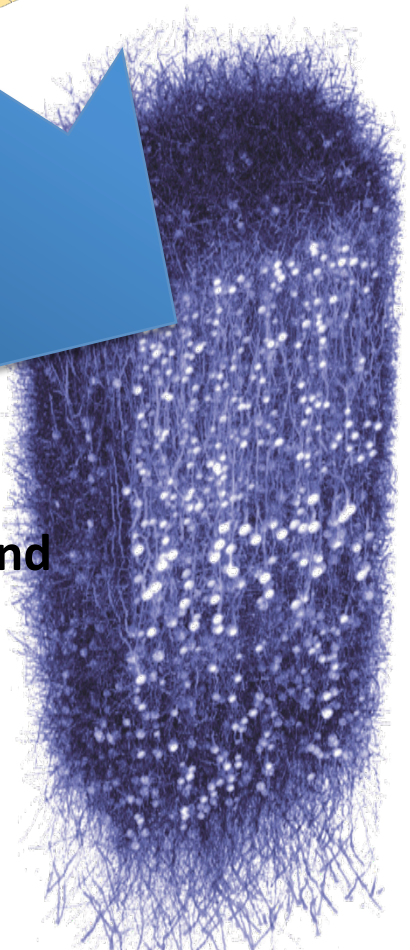


Current Area of Research Interest

- Simulation-based research in neuroscience
- high-performance computing and simulation-steering
- integrative computing workflows

Challenges that May be Addressed with Advanced Computing and Mathematics Capabilities

- hypothesis-driven drug development
- personalized medicine
- reducing animal experimentation

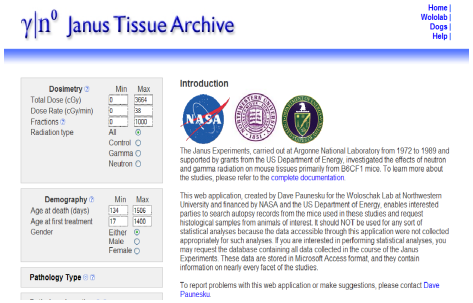


Woloschak Lab

- Current Research: (janus.northwestern.edu/wololab):

-Studies of radiation on late tissue toxicities including cancer—DOE

-Development of nanoparticles for imaging and therapy of cancer—NCI



- Challenges/Other areas:

-modeling radiation toxicity at the tissue/organism level (applications to RadOnc)

-modeling effects of different radiation qualities (low LET, p+ for RadOnc; p+, HZE for NASA); modeling interactions of different radiation qualities

-modeling interaction of radiation with other toxicities (chemo for cancer therapy; heavy metals for environmental concerns; others)

-modeling toxicities of various nanoparticles (different materials, sizes, molecules bound, shapes) on tissues, organisms; modeling toxicities of nanoparticles coupled with other materials (applications to nanotech, cancer, therapies, environmental concerns)

-modeling which nanoparticles will be able to accumulate in tissues/tumors due to EPR (enhanced permeability and retention)—(applications to cancer therapy and imaging)